I Claim:

1. Apparatus for producing grain of certain size and purity comprising a chamber, a valved vent connected to the chamber for withdrawing unwanted gasses, a valved vacuum line connected to the chamber for reducing pressure in the chamber, a valved gas inlet connected to the chamber for introducing inert gas into the chamber, at least one heater connected to the chamber for heating purposes and at least one plasma source connected to the chamber, a powder source connected to the chamber for supplying powder to the chamber for heating, softening, drying and purifying, and agglomerating powder particles into larger powder grains, a collector in the chamber for collecting the powder grains.

2. The apparatus of claim 1, wherein the powder is an oxide.

3. The apparatus of claim 2, wherein the oxide is selected from a group consisting of SiO_2, B_2O_5, P_2O_5, Al_2O_3, GeO_2, Sb_2O_3, Nb_2O_5, TiO_2, ZrO_2, and combinations thereof.

4. The apparatus of claim 1, wherein the powder is a nitride.

5. The apparatus of claim 4, wherein the nitride is Si_3N_4.

6. The apparatus of claim 1, wherein the powder is a compound.

7. The apparatus of claim 1, wherein the collector is positioned in the chamber beneath the plasma.

8. The apparatus of claim 7, further comprising a moving device connected to the collector for rotating the collector and raising and lowering the collector.

9. The apparatus of claim 8, wherein the valved vacuum line is located downward in the chamber for creating a differential pressure in the chamber with higher pressures toward a top of the chamber and lower pressures near a bottom of the chamber.

10. The apparatus of claim 9, wherein the plasma is centered in the chamber above the collector.

11. The apparatus of claim 10, wherein the powder is silica powder.

12. The apparatus of claim 10, wherein the powder source is connected to the

chamber above the plasma.

13. The apparatus of claim 1, wherein the powder source comprises small grain powder introduction ports at a top of the chamber.

14. The apparatus of claim 1, wherein the powder source comprises a plurality of burners connected to the top of the chamber for burning precursors in the chamber and for generating the powder in the chamber.

15. The apparatus of claim 1, wherein the powder source comprises small grain powder introduction ports at a top of the chamber and a plurality of burners connected to the top of the chamber for burning precursors in the chamber and for generating the powder in the chamber.

16. The apparatus of claim 1, wherein the gas inlet is positioned in the chamber opposite the plasma for providing inert gas to the plasma.

17. The apparatus of claim 1 wherein the collector comprises a heated holder for holding the silica grains and further comprising a dopant gas input line connected to the heated holder for passing dopant gas through the silica grains in the heated holder.

18. The apparatus of claim 17, further comprising a second vacuum chamber below the first chamber.

19. The apparatus of claim 17, wherein the heated holder further comprises a crucible for softening and fusing.

20. The apparatus of claim 17, wherein the heated holder further comprises a crucible for softening and fusing silica.

21. The apparatus of claim 20, further comprising a flow director connected to the crucible for flowing the fused and softened silica from the crucible.

22. The apparatus of claim 19, further comprising a seal and a puller connected to the chamber for pulling the flowing fused silica from the chamber.

23. The apparatus of claim 23, further comprising multiple heaters and multiple heat

zones in the chamber for heating the zones to different temperatures.

24. The apparatus of claim 23, wherein the multiple heat zones further comprise plural heat zones in the chamber.

25. The apparatus of claim 1, wherein the at least one heater comprises plural heaters for heating the plasma in distinct heat zones.

26. The apparatus of claim 25, wherein the at least one heater comprises plural microwave heaters for heating the chamber in distinct heat zones.

27. The apparatus of claim 25, wherein the at least one heater comprises plural radio frequency heaters for heating the plasma in distinct heat zones.

28. The apparatus of claim 25, wherein the at least one heater comprises plural microwave heaters for heating the chamber in distinct heat zones.

29. The apparatus of claim 25, wherein the at least one heater comprises plural resistive heaters for heating the chamber in distinct heat zones.

30. The apparatus of claim 25, wherein at least one heater comprises plural radiative heaters for heating the chamber in distinct heat zones.

31. The apparatus of claim 26, further comprising a plasma surface removal unit mounted beneath the seal and puller for finishing a surface of the fused silica being pulled from the chamber.

32. The apparatus of claim 1, wherein the chamber comprises a first chamber and further comprises a plate/bar fabrication vacuum chamber having an input connected to an output of the first chamber, the fabrication chamber having a plurality of valved vacuum ports, gas inlet ports, vent ports, and a fused silica feed material introduction port, resistance of RF heating connected through a plurality of feedthroughs, a crucible made from graphite, silicon carbide, ceramic material, metal or metal alloys for receiving the feed material from the first chamber, softening and solidifying the material, a plurality of ultrasound or other vibration generators in contract with the crucible for promoting proper mixing and outgassing, and additional vacuum

ports placed above the softened materials for removing any gas bubbles.

33. The apparatus of claim 32, wherein the fabrication chamber comprises a plurality of chambers.

34. The apparatus of claim 1, wherein the collector further comprises fused silica fiber optic preforms, comprising a plurality of substrates relatively rotating with respect to each other in the chamber, wherein the at least one heater comprises a plurality of heaters for heating the chamber and the substrates, wherein the powder source comprises plural powder sources for directing silica particles inward in the chamber toward the substrates, fusing silica particles on the substrates, and sticking particles to particles held on the substrates and forming porous silica preforms on the substrates, and further comprising a mover for relatively moving the substrates and preforms in the chamber.

35. The apparatus of claim 34, wherein the plural powder sources comprise powder generators for generating silica particles with pyrolysis of silica particle precursors from wall-mounted burners.

36. The apparatus of claim 34, wherein the powder sources further comprise silica particle injectors for directing powder streams toward the substrates and preforms.

37. The Apparatus of claim 34, wherein the powder sources further comprise injectors for injecting jets of silica particles mixed with gas in neutral or excited plasma state.

38. The apparatus of claim 34, wherein the powder sources further comprise injectors for injecting silica particle streams that contain solid or gaseous dopants and gases in neutral or excited charged, plasma state.

39. The apparatus of claim 34, further comprising dopant gas injectors in the chamber and substrate, purge gas injectors in the chamber and substrate, and vents connected to the chamber for venting and removing gases form the chamber.

40. The apparatus of claim 34, wherein the mover comprises relatively rotating and translating movers connected to the substrates and preforms within the chamber.

41. The apparatus of claim 1, wherein the powder source comprises burners mounted near walls of the chamber for pyrolysis of silicon compositions for generating silica powder.

42. The apparatus of claim 1, further comprising a dopant source comprising burners mounted near or on the walls of the chamber for pyrolysis of dopant compositions for generating dopants in the chamber.

43. The apparatus of claim 1, further comprising dopant powder sources comprising dopant powder injectors near or on chamber walls.

44. The apparatus of claim 1, wherein the powder source comprises silica powder injectors near walls of the chamber.

45. The apparatus of claim 1, further comprising a mover having rotation and translation mechanisms connected to the collector for rotating and translating the collector in the chamber.

46. Apparatus for forming a fused silica grains, comprising an elongated chamber, a pressure control connected to the chamber, controlling pressure in the chamber, at least one collector mounted in the chamber, silica particle providers connected to the chamber for supplying silica particles in the chamber and directing the silica particles toward the collector, at least one heater connected to or near the chamber wall for supplying heat to the collector and at least one heater in the chamber and for directing heat to the silica particles for softening surfaces of the particles for sticking and agglomerating the particles on other heated particles and on the collector for collecting the particles with softened surfaces on the collector.

47. The apparatus of claim 46, further comprising a rotation assembly mounted on the chamber and connected to the at least one collector for relatively rotating the collector with respect to the chamber.

48. The apparatus of claim 46, wherein the pressure control comprises at least one reduced pressure port in the chamber for venting and withdrawing gas.

49. The apparatus of claim 46, further comprising at least one inlet port in the

chamber for introducing purgant, dopant or oxidant gas into the chamber.

50. The apparatus of claim 46, wherein the at least one heater comprises at least one radiant heater in the chamber for directing heat to the silica particles in the chamber.

51. The apparatus of claim 50, wherein the radiant heater is a resistive heater.

52. The apparatus of claim 50, wherein the radiant heater is an infrared heater.

53. The apparatus of claim 46, wherein the at least one heater comprises a radio frequency heater in the chamber for directing heat to the at least one collector and the particles in the chamber.

54. The apparatus of claim 46, wherein the at least one heater comprises a microwave heater.

55. The apparatus of claim 46, wherein the at least one heater comprises plural heaters in the chamber for heating plural heat zones along the elongated chamber.

56. The apparatus of claim 46, further comprising a translation mechanism connected to the chamber and the collector for relatively translating the collector with respect to the chamber.

57. The apparatus of claim 46, wherein the silica particle providers comprise burners for introducing and pyrolysizing compounds in the chamber for providing the silica particles in the chamber.

58. The apparatus of claim 46, wherein the silica particle providers comprise silica powder stream injectors in the chamber for directing preformed silica powder toward the collector.

59. The apparatus of claim 46, further comprising a crucible with a heated throat for fusing and softening the silica and an openable lower end for flowing softened fused silica.

60. The apparatus of claim 59, further comprising a rotating and pulling mechanism near a lower end of the chamber for rotating and pulling the softened fused silica from the chamber.

61. The apparatus of claim 60, wherein the softened and fused silica is pulled from the chamber as a tube.

62. The apparatus of claim 60, wherein the softened and fused silica is pulled from the chamber as a rod.

63. The apparatus of claim 60, wherein the at least one heater further comprises a resistance heater connected to the crucible for softening fused silica in the crucible.

64. The apparatus of claim 60, further comprising electrodes near the softened silica and an electric field generator connected to the electrodes for providing an electric field in the softened silica.

65. The apparatus of claim 64, wherein at least one of the electrodes is on one side of the softened silica, and wherein at least one other of the electrodes is on an opposite side of the softened silica for providing an electric field through the softened silica.

66. The apparatus of claim 65, wherein the softened silica flowing from the preform forms a tubular bubble, wherein the at least one of the electrodes is outside of the tubular bubble, and wherein the at least one other of the electrodes is within the tubular bubble.

67. The apparatus of claim 66, wherein the electrodes are concentric ring electrodes.

68. The apparatus of claim 60, further comprising a second chamber having a crucible tray for receiving the softened silica from the first chamber, and at least one second chamber heater in the second chamber for heating the fused softened silica and reforming the silica in a desired form in the crucible tray.

69. The apparatus of claim 68, further comprising ultra sound or other oscillating frequency generators in the second chamber adjacent the crucible tray for outgassing gas from the softened reformed fused silica.

70. The apparatus of claim 69, further comprising additional vacuum ports near the crucible tray for removing gases outgassed from the softened reformed fused silica.

71. The apparatus of claim 46, wherein the particle providers are mounted in an upper

part of the chamber and are oriented for directing particles inward into a mass of particles, and wherein the at least one heater comprises a resistive, radio frequency, plasma heating or other heater for heating particles and softening surfaces of the particles in the mass of particles, and wherein the collector comprises a first heated crucible positioned with respect to the mass of particles for collecting particles and agglomerations of particles from the mass, the first heated crucible having a lower heated throat with a heater for softening, fusing and flowing fused silica from the first crucible.

72. The apparatus of claim 71, further comprising a flow director mounted beneath the lower heated throat for directing flow of the flowing fused silica as a tubular or solid member having round, rectangular or polygonal cross-section.

73. The apparatus of claim 72, further comprising a purging gas or dopant injector connected to the flow director for supplying purging gas or dopant to the flowing fused silica.

74. The apparatus of claim 73, further comprising a second crucible positioned below the heated throat for receiving flowing fused silica, and a purging gas or dopant injector in the second crucible for injecting purging gas or dopant in the fused silica in the second crucible.

75. The apparatus of claim 74, further comprising a second chamber having a crucible tray for receiving the softened silica from the second crucible, and at least one second chamber heater in the second chamber for heating the fused softened silica and reforming the silica in a desired form in the crucible tray.

76. The apparatus of claim 75, further comprising ultra sound or other oscillations generators in the second chamber adjacent the crucible tray for outgassing gas from the softened reformed fused silica in the crucible tray.

77. The apparatus of claim 76, further comprising vacuum ports near the crucible tray for removing gases outgassed from the softened reformed fused silica.

78. A method for producing silica grain comprising providing a chamber, providing a valved vent connected to the chamber, and withdrawing unwanted gasses, providing a valved

vacuum line connected to the chamber and reducing pressure in the chamber, providing a valved gas inlet connected to the chamber and introducing inert gas into the chamber, providing at least one heater connected to the chamber and forming a hot plasma in the chamber, providing a silica powder source connected to the chamber and supplying silica powder to the hot plasma in the chamber, heating, softening, drying and removing OH, and agglomerating powder particles into larger silica grains and providing a collector in the chamber for collecting the silica grains.

79. The method of claim 78, further comprising positioning the collector in the chamber beneath the plasma.

80. The method of claim 79, further comprising providing a moving device connected to the collector and rotating the collector and raising and lowering the collector.

81. The method of claim 80, further comprising locating the valved vacuum line downward in the chamber and creating a differential pressure in the chamber with higher pressures toward a top of the chamber and lower pressures near a bottom of the chamber.

82. The method of claim 81, further comprising centering the plasma in the chamber above the collector.

83. The method of claim 82, further comprising connecting the silica powder source to the chamber above the plasma.

84. The method of claim 83, wherein the providing the silica powder source comprises providing small grain silica powder introduction ports near a top of the chamber.

85. The method of claim 83, wherein the providing the silica powder source comprises providing a plurality of burners connected to the top of the chamber, burning silica precursors in the chamber and generating the silica powder in the chamber.

86. The method of claim 83, wherein the providing the silica powder source comprises providing small grain silica powder introduction ports at a top of the chamber and providing a plurality of burners connected to the top of the chamber, burning silica precursors in the chamber and generating the silica powder in the chamber.

87. The method of claim 86, wherein the supplying the silica powder comprises introducing the silica powder together with a gas plasma or a plasma/neutral gas mixture.

88. The method of claim 78, further comprising positioning the gas inlet in the chamber opposite the plasma and providing inert gas to the plasma.

89. The method of claim 78, wherein the introducing the inert gas comprises introducing pure inert gas.

90. The method of claim 78, wherein the introducing the inert gas comprises introducing an inert gas mixed with other inert gasses.

91. The method of claim 78, wherein the introducing the inert gas comprises introducing an inert gas mixed with reactive gas for additional silica powder purification

92. The method of claim 78, wherein providing the collector comprises providing a heated holder, holding the silica grains on the holder, and further comprising providing a purging, reactive or dopant gas input line connected to the heated holder and passing purging, reacting, or dopant gas through the silica grains on the heated holder.

93. The method of claim 92, wherein the providing the purging reactive or dopant gas comprises providing chemically reactive gas, plasma or gas plasma and neutral mix.

94. The method of claim 92, further comprising providing a second vacuum chamber below the first chamber.

95. The method of claim 92, wherein the providing the heated holder further comprises providing a crucible, and softening, fusing and flowing the silica.

96. The method of claim 95, further comprising providing a flow director connected to the crucible and flowing the fused softened silica from the crucible.

97. The method of claim 95, further comprising providing a seal and a puller connected to the chamber and pulling the flowing fused silica from the chamber.

98. The method of claim 78, further comprising providing multiple heat zones in the chamber and heating the zones to different temperatures.

99. The method of claim 97, wherein providing the multiple heat zones further comprises providing plural heat zones adjacent the plasma and heating the plasma in the distinct heat zones.

100. The method of claim 98, wherein the providing the multiple heat zones comprises providing plural microwave heaters and heating the plasma in distinct heat zones.

101. The method of claim 78, wherein the providing the at least one heater comprises providing plural microwave heaters and heating the chamber in distinct heat zones.

102. The method of claim 78, wherein the providing the at least one heater comprises providing plural radio frequency heaters and heating the plasma in distinct heat zones.

103. The method of claim 78, wherein the providing the at least one heater comprises providing resistive, RF and IR heaters and heating the chamber in distinct heat zones.

104. The method of claim 78, wherein the providing the at least one heater comprises providing resistive, RF and IR heaters and heating the plasma in distinct heat zones.

105. The method of claim 78, wherein the forming a hot plasma comprises providing a plurality of microwave plasma generators for producing plasma for the chamber.

106. The method of claim 97, further comprising providing a gas plasma surface removal unit mounted beneath the seal and puller and finishing a surface of the tube being pulled from the chamber.

107. The method of claim 78, further comprising providing a plate/bar fabrication vacuum chamber having an input connected to an output of the first chamber, providing on the fabrication chamber a plurality of valved vacuum ports, gas inlet ports, vent ports, providing a fused silica feed material introduction port, as the input, providing resistance or RF heating connected through a plurality of feedthroughs, providing a crucible tray made from graphite, silicon carbide, ceramic material, metal or metal alloys for receiving the feed material from the first chamber, softening and solidifying of the material in the crucible tray, providing a plurality of ultrasound or other oscillation generators in contact with the crucible tray for promoting

proper mixing and outgassing, and providing additional vacuum ports above the softened materials for removing any gas bubbles.

108. The method of claim 107, wherein providing the fabrication chamber comprises providing a plurality of fabrication chambers.

109. A method of producing fused silica fiber optic preforms, comprising providing relatively rotating a plurality of substrates with respect to each other in a chamber, heating the chamber and the substrates, directing silica particles and dopant inward in the chamber toward the substrates, heating the substrates, fusing silica particles on the substrates, and sticking particles to particles held on the substrates and forming silica preforms on the substrates, and relatively moving the substrates and preforms in the chamber.

110. The method of claim 109, wherein the providing of silica particles comprises generating silica particles with pyrolysis of silica particle precursors from wall-mounted burners.

111. The method of claim 109, wherein the directing further comprises directing silica particle streams toward the substrates and preforms.

112. The method of claim 111, further comprising mixing the streams of silica particles with neutral or plasma gases.

113. The method of claim 111, further comprising mixing the streams of silica particles with dopant and neutral or plasma gases.

114. The method of claim 111, further comprising providing dopant gases to the chamber and through the substrate, and providing purge gas to the chamber and through the substrate, and venting and removing gases from the chamber.

115. The method of claim 109, wherein the moving comprises relatively rotating and translating the substrates and preforms within the chamber.

116. The method of claim 109, wherein the directing silica particles comprises providing burners mounted near walls of the chamber, pyrolyzing silicon compositions and generating silica powder.

117. The method of claim 109, wherein the directing silica particles comprises providing silica powder injectors near walls of the chamber.

118. The method of claim 109, wherein the moving further comprises providing a mover, providing rotation and translation mechanisms connected to the substrates and rotating and translating the substrates in the chamber.

119. A method for providing fused silica grains, comprising providing an elongated chamber, providing a pressure control connected to the chamber, controlling pressure in the chamber, providing at least one collector mounted in the chamber, disposing silica particle providers connected to the chamber and supplying doped and undoped silica particles in the chamber, and directing the silica particles toward the at least one collector, providing at least one heater connected to the chamber, supplying heat to the collector and supplying heat to the chamber, directing heat to the silica particles, softening surfaces of the particles, sticking and agglomerating the particles with other heated particles, and with the collector and collecting the particles.

120. The method of claim 119, further comprising providing a rotation assembly mounted on the chamber, connecting the rotating assembly to the at least one collector and relatively rotating the collector with respect to the chamber.

121. The method of claim 119, wherein the providing the pressure control comprises providing at least one reduced pressure port in the chamber and venting and withdrawing gas.

122. The method of claim 119, further comprising providing at least one inlet port in the chamber and introducing purgant, dopant or oxidant gas into the chamber.

123. The method of claim 119, wherein providing the at least one heater comprises providing at least one radiant heater in the chamber and directing heat to the silica particles in the chamber.

124. The method of claim 119, wherein providing the at least one heater comprises providing a radio frequency heater in the chamber and directing heat to the substrate, the preform

and the particles in the chamber.

125. The method of claim 119, wherein providing the at least one heater comprises providing a microwave gas plasma generator.

126. The method of claim 119, wherein providing the at least one heater comprises providing plural heaters in the chamber and heating plural heat zones along the elongated chamber.

127. The method of claim 119, further comprising providing a translation mechanism connected to the chamber and the collector and relatively translating the collector with respect to the chamber.

128. The method of claim 119, wherein the disposing the silica particle providers comprises providing burners for introducing and pyrolyzing or oxidizing compounds in the chamber and providing the silica particles in the chamber.

129. The method of claim 119, wherein the disposing the silica particle providers comprise providing silica powder stream injectors in the chamber and directing preformed silica powder toward the collector.

130. The method of claim 119, further comprising providing a crucible with a heated throat fusing and softening the silica and an open lower end and flowing the softened fused silica.

131. The method of claim 130, further comprising providing a rotating and pulling mechanism near a lower end of the chamber and rotating and pulling the softened fused silica from the chamber.

132. The method of claim 131, wherein pulling the softened and fused silica comprises pulling the silica from the chamber as a tube.

133. The method of claim 131, wherein pulling the softened and fused silica comprises pulling the silica from the chamber as a rod.

134. The method of claim 131, wherein providing the at least one heater further comprises providing a resistance heater connected to the crucible and softening fused silica in the

crucible.

135. The method of claim 137, further comprising providing electrodes near the softened silica, providing an electric field generator connected to the electrodes and providing an electric field in the softened silica.

136. The method of claim 135, wherein the providing the electrodes comprises providing at least one of the electrodes on one side of the softened silica, providing at least one other of the electrodes on an opposite side of the softened silica and providing the electric field through the softened silica.

137. The method of claim 136, wherein the flowing the softened silica comprises forming a tubular bubble, wherein the providing the electrodes comprises providing the at least one of the electrodes outside of the tubular bubble, and providing the at least one other of the electrodes within the tubular bubble.

138. The method of claim 137, wherein the providing the electrodes comprises providing concentric ring electrodes.

139. The method of claim 131, further comprising providing a second chamber providing a crucible tray, receiving the softened silica from the first chamber, and providing at least one second chamber heater in the second chamber, heating the fused softened silica and reforming the silica in a desired form in the crucible tray.

140. The method of claim 139, further comprising providing ultrasound or other oscillation generators in the second chamber adjacent the crucible tray and outgassing gas from the softened reformed fused silica.

141. The method of claim 140, further comprising providing additional vacuum ports near the crucible tray and removing gases outgassed from the softened reformed fused silica.

142. The method of claim 119, wherein the disposing comprises mounting the particle providers in an upper part of the chamber and directing particles inward into a mass of particles, wherein providing the at least one heater comprises providing a resistive, radio frequency,

plasma or other heater and heating particles and softening surfaces of the particles in the mass of particles, and wherein the providing the collector comprises providing a first heated crucible positioned with respect to the mass of particles collecting softened particles and agglomerations of softened surface particles from the mass in the first heated crucible, providing a lower throat, heating the throat, softening, fusing and flowing fused silica from the first crucible through the throat.

143. The method of claim 142, further comprising providing a flow director mounted beneath the lower heated throat and flowing of the flowing fused silica as a tubular or solid member having round, rectangular or polygonal cross-section.

144. The method of claim 143, further comprising connecting a purging or dopant injector to the flow director and supplying purging gas and dopant to the flowing fused silica.

145. The method of claim 143, further comprising positioning a second crucible below the heated throat and receiving flowing fused silica, and providing a purging gas or dopant injector in the second crucible and injecting purging gas or dopant in the fused silica in the second crucible.

146. The method of claim 149, further comprising providing a second chamber providing a crucible tray in the second chamber, receiving the softened silica from the first chamber in the crucible tray, and providing at least one second chamber heater in the second chamber, heating the fused softened silica and reforming the silica in a desired form in the crucible tray.

147. The method of claim 146, further comprising providing ultrasound or other oscillation generators in the second chamber adjacent the crucible tray and outgassing gas from the softened reformed fused silica.

148. The method of claim 147, further comprising providing additional vacuum ports near the crucible tray and removing gases outgassed from the softened reformed fused silica.